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EFFECT OF FEEDING GREEN ALFALFA AND GREEN CORN ON FLAVOR AND ODOR OF MILK.

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CAUSES OF UNDESIRABLE FLAVORS AND ODORS IN MILK.

During times when pastures are short, in the summer months, or in intensive farming where pasture land is not available, the dairyman is forced to seek means to prevent milk production from decreasing below a normal level. Usually one of two methods is employed—either sufficient silage is provided for year-round feeding or soiling crops are used.

Green alfalfa and green corn make excellent soiling crops. The rapid growth of green alfalfa, both during early spring and after cutting, together with the fact that it yields fron three to five cuttings during the season, enables the grower to have a supply available for feeding from comparatively early spring until late fall. Alfalfa is also used frequently as pasturage. Green corn is commonly grown as a crop for feeding cows, because it is available during the late summer, when pastures are likely to be dry and short.

Cow's milk has more or less pronounced flavors and odors.[1] These flavors vary from those that are pleasing to the taste to others

[1] The effect of silage on the flavor and odor of milk has been studied and reported in United States Department of Agriculture Bulletin No. 1097, The Effect of Silage on the Flavor and Odor of Milk.

Note.—The author acknowledges the assistance of T. E. Woodward, in charge of the dairy experiment farm, Beltsville, Md., and of H. T. Converse, dairy husbandman, who supervised the experimental work at the farm. Thanks are due also to members of the market milk section of the Dairy Division, who judged the many samples of milk.

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which make the milk objectionable and unpalatable. Such variations in flavor and odor are attributed to four causes:

1. The internal or physical condition of the individual cow.
2. Absorption within the body of the cow from highly flavored feeds.
3. Absorption into the milk after production.
4. Bacterial development within the milk on standing.

Succulent feeds, such as green alfalfa and green corn, may have a tendency to impart undesirable flavors and odors to milk. In order to determine to what extent this is true, experiments were conducted by the Dairy Division at its experiment farm at Beltsville, Md. It was assumed that the effect of feeding green alfalfa on the flavor and odor of milk is similar when used either as soiling crop or pasturage. The objects of the investigation may be outlined as follows:

To determine whether feeding green alfalfa or green corn does affect the flavor and odor of milk.

If that is the case, to determine how these feeds may be so fed and the milk so handled as to minimize their effect, if objectionable, on the quality of the product.

EXPERIMENTAL FEEDING OF GREEN ALFALFA.

PROCEDURE.

COWS.

The investigation in regard to green alfalfa was begun with 10 purebred Jersey cows; as the work proceeded it became necessary to release some of the cows at various times and substitute others. As a result both Jersey and Holstein cows were used during the investigation. So far as possible, cows were selected giving milk relatively free from abnormal flavors and odors when fed the basic hay and grain ration. The cows were representative of their respective breeds, the average weight of the Jerseys being 798 pounds, while the Holsteins averaged 1,186 pounds.

The stage of lactation varied from fresh cows to those nearing the end of their lactation period. The average daily milk production of the Jersey cows was 19 pounds, the highest individual daily average being 29.5 pounds and the lowest 8.7 pounds. The Holstein cows gave an average daily milk production of 30.5 pounds, the highest individual daily average being 49.6 pounds and the lowest 18 pounds. The average daily milk production of all cows was 22.1 pounds.

FEED OTHER THAN GREEN ALFALFA.

In addition to green alfalfa, the cows received varying amounts of the following grain mixture: Hominy feed, bran, and oats, 100 pounds each; cottonseed meal and linseed meal, 50 pounds each. The amount fed varied with the amount of milk produced. The daily average to all the cows was 10.4 pounds. The largest average amount received by an individual cow was 14.4 pounds, the smallest 2.4 pounds.

The ration was then completed by feeding the cows what cured alfalfa hay they would readily consume. This varied considerably, ranging from none to 18 pounds, depending upon the amount of green alfalfa the cows were receiving. The average daily amount received was 9.8 pounds.

GREEN ALFALFA.

The green alfalfa was practically free from weeds and other foreign growth. Feeding was begun 15 days before the time the alfalfa was ready to cut for hay and continued for 23 days. Eleven days later the investigation was continued with the second cutting from the same field. At this time the alfalfa was beginning to bloom, and as approximately the same amount was fed each day as during the first cutting, the alfalfa remained practically at the same stage of maturity until the completion of the investigation.

METHOD OF FEEDING.

The cows were divided into groups of two each. The cows in one group received only the basic hay and grain ration and were known as checks. The other groups received, in addition to the hay and grain ration, the following amounts of green alfalfa twice daily:

One group, 15 pounds one hour before milking.
One group, 30 pounds one hour before milking.
One group, 15 pounds immediately after milking.
One group, 30 pounds immediately after milking.

The cows were fed these rations for five days, then for two days no green alfalfa was fed, after which the cows in the various groups were interchanged in order to equalize any abnormal results due to the milk of any individual animal, and the feeding of green alfalfa was resumed.

MILK SAMPLES.

Samples from the milk of individual cows were taken at the time of milking, given a key number, and cooled but not aerated. The samples were then judged for flavor and odor by experienced milk judges without knowledge of the key. The following classification was used, in which "off" signifies those flavors and odors which the judges believed to be due to feed: Normal; very slightly off; slightly off; off. When no off flavor or odor was perceptible the sample was rated normal; where an off flavor or odor was perceived the sample was rated according to the degree which the judge considered it to be off. It is doubtful whether the off flavor or odor in samples rated very slightly off would be noticed by many people other than those accustomed to judge milk and cream, and very likely the average consumer would have no serious objection to those samples rated as slightly off. An "opinion" denotes the decision of one judge in regard to one sample.

CHECK SAMPLES.

The check samples were taken from the milk of the check cows, which were fed only the basic hay and grain ration. Some off flavors and odors were noted in these samples, but they were mostly very slight, and undoubtedly were instances of the slight off flavors and odors frequently encountered in milk from individual cows.

Out of a total of 329 opinions obtained on 75 check samples, 90.3 per cent of the opinions on flavor and 88.7 per cent of those on odor were "normal." The greater part of the off flavors and odors, i. e., 8.2 per cent and 6.7 per cent of the opinions on the flavor and odor,

respectively, were rated as very slightly off. Of the opinions on flavor 1.2 per cent and of the opinions on odor 4.3 per cent were rated slightly off, while one opinion, or 0.3 per cent, rated a sample off in both flavor and odor. (See Table 1 and fig. 1.)

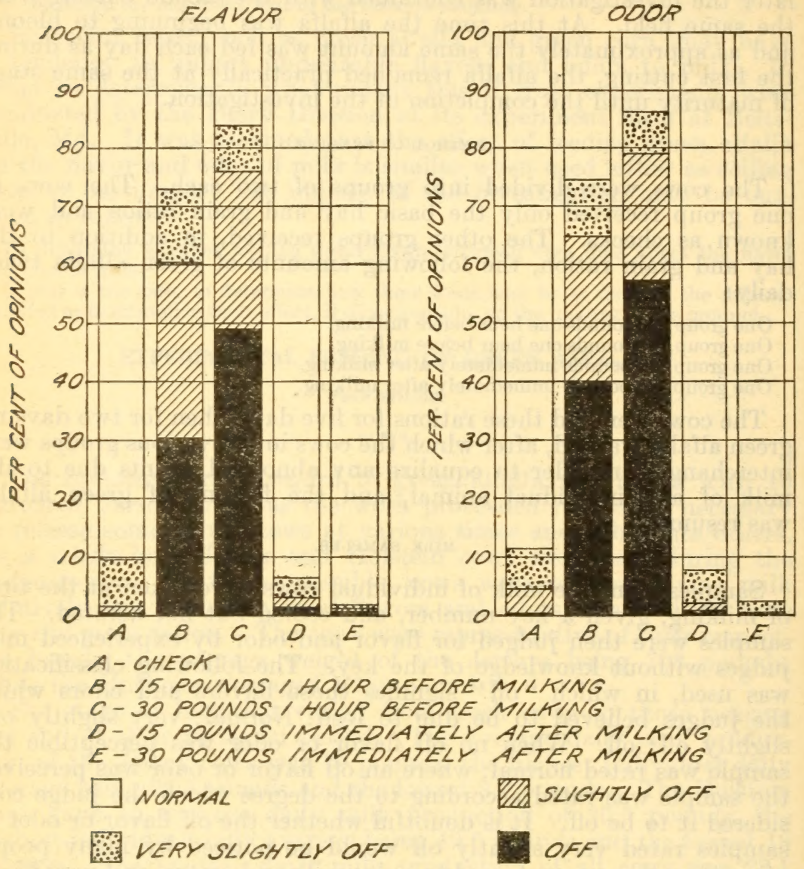

FIG. 1.—Effect of feeding green alfalfa on flavor and odor of milk. The degree of shading shows the relative intensity of the flavor and odor produced.

TABLE 1.—*Opinions on flavor and odor of 75 samples of milk from cows fed basic ration of hay and grain (check cows).*

Rating.	Flavor.		Odor.	
	Opinions.	Per cent.	Opinions.	Per cent.
Normal	297	90.3	292	88.7
Very slightly off	27	8.2	22	6.7
Slightly off	4	1.2	14	4.3
Off	1	.3	1	.3
Total	329	100.0	329	100.0

FEEDING 15 POUNDS ONE HOUR BEFORE MILKING.

Feeding 15 pounds of green alfalfa, which constitutes about half of a full feed, affected the flavor and odor of the milk. In a total of 378 opinions on 85 samples of milk produced by cows receiving this amount of green alfalfa, 27 per cent and 25.4 per cent of the opinions rated the milk normal on flavor and odor, respectively. Opinions on flavors were about equally divided between slightly off and off, 29.9 per cent rating the samples slightly off and 30.4 per cent rating them off, while 12.7 per cent rated them very slightly off. Off odors were more readily perceived than off flavors; a larger per cent of opinions rated the samples off in odor than in flavor; 39.9 per cent, 24.9 per cent, and 9.8 per cent rated the samples off, slightly off, and very slightly off, respectively. (See Table 2 and fig. 1.)

TABLE 2.—*Opinions on flavor and odor of 85 samples of milk from cows fed 15 pounds of green alfalfa one hour before milking.*

Rating.	Flavor.		Odor.	
	Opinions.	Per cent.	Opinions.	Per cent.
Normal	102	27.0	96	25.4
Very slightly off	48	12.7	37	9.8
Slightly off	113	29.9	94	24.9
Off	115	30.4	151	39.9
Total	378	100.0	378	100.0

FEEDING 30 POUNDS ONE HOUR BEFORE MILKING.

Increasing the amount of green alfalfa, fed one hour before milking, to 30 pounds had a more marked effect on the flavor and odor of milk. Out of a total of 521 opinions on 115 samples of milk produced by cows fed this amount, only 16.1 per cent and 13.8 per cent of the opinions rated the milk normal on flavor and odor, respectively. Likewise the number of opinions rating the milk as very slightly off decreased somewhat as compared with feeding 15 pounds; 7.9 per cent and 27.1 per cent rated the flavor of the milk as very slightly off and slightly off, respectively, while 7.1 per cent and 21.9 per cent gave similar ratings to the odor.

These figures show that increasing the amount fed of green alfalfa intensified the off flavors and odors in the milk. By increasing the amount of green alfalfa from 15 to 30 pounds, the opinions rating the milk as off on flavor were increased from 30.4 to 48.9 per cent, and those rating the milk as off on odor increased from 39.9 to 57.2 per cent. (See Table 3 and fig. 1.)

TABLE 3.—*Opinions on flavor and odor of 115 samples of milk from cows fed 30 pounds of green alfalfa one hour before milking.*

Rating.	Flavor.		Odor.	
	Opinions.	Per cent.	Opinions.	Per cent.
Normal	84	16.1	72	13.8
Very slightly off	41	7.9	37	7.1
Slightly off	141	27.1	114	21.9
Off	255	48.9	298	57.2
Total	521	100.0	521	100.0

FEEDING 15 POUNDS IMMEDIATELY AFTER MILKING.

Feeding green alfalfa at the rate of 15 pounds immediately after milking had practically no effect on either the flavor or odor of the milk. A total of 234 opinions on 48 samples of milk produced by cows receiving this amount after milking showed 93.6 per cent of the opinions rated the samples as normal in flavor and 92.3 per cent normal in odor. This is slightly higher than the per cent of normal opinions on the check samples. Of the opinions designating off flavors and odors, those rating the samples as very slightly off were most numerous, 3.4 per cent representing flavor and 5.6 per cent representing odor; while 1.7 per cent and 1.3 per cent of the opinions rated the flavor slightly off and off, respectively, and 1.3 per cent and 0.8 per cent gave the same ratings to the odor. (See Table 4 and fig. 1.)

TABLE 4.—*Opinions on flavor and odor of 48 samples of milk from cows fed 15 pounds of green alfalfa immediately after milking.*

Rating.	Flavor.		Odor.	
	Opinions.	Per cent.	Opinions.	Per cent.
Normal	219	93.6	216	92.3
Very slightly off	8	3.4	13	5.6
Slightly off	4	1.7	3	1.3
Off	3	1.3	2	.8
Total	234	100.0	234	100.0

FEEDING 30 POUNDS IMMEDIATELY AFTER MILKING.

Feeding 30 pounds of green alfalfa immediately after milking apparently improved the flavor and odor of the milk. A total of 181 opinions on 43 samples of milk produced by cows fed this amount after milking showed 98.35 per cent of the opinions rating the samples as normal in flavor and 97.8 per cent normal in odor. The few opinions rating the milk off in flavor were equally divided among the three different groups, 0.55 per cent being allocated to each. In the case of off odors there was a slight increase in the number of opinions rating the samples very slightly off, 1.7 per cent representing this group. One opinion, or 0.5 per cent of the total number, rated the samples off, while none rated them slightly off. (See Table 5 and fig. 1.)

TABLE 5.—*Opinions on flavor and odor of 43 samples of milk from cows fed 30 pounds of green alfalfa immediately after milking.*

Rating.	Flavor.		Odor.	
	Opinions.	Per cent.	Opinions.	Per cent.
Normal	178	98.35	177	97.8
Very slightly off	1	.55	3	1.7
Slightly off	1	.55	0	.0
Off	1	.55	1	.5
Total	181	100.00	181	100.0

Tables 1 and 5 indicate that samples from cows fed this amount of green alfalfa immediately after milking had less off flavor and odor than milk from cows not fed green alfalfa. This is probably because the alfalfa overcomes the slightly off flavors and odors frequently encountered in the milk of individual cows, either by giving a better tone to the milk or by improving the physical condition of the cow.

FEEDING 30 POUNDS THREE AND FIVE HOURS BEFORE MILKING.

In order to determine the length of time after feeding green alfalfa to dairy cows that the off flavors and odors produced by this feed are perceptible in the milk, one group of cows was fed 30 pounds three hours before milking and another group 30 pounds five hours before milking.

Feeding this amount of green alfalfa three hours before milking decreased the intensity of the off flavors and odors in the milk, as compared with feeding one hour before milking. Ninety-four opinions on 27 samples of milk produced by cows fed in this manner showed 23.4 per cent of the opinions rating the milk normal in flavor and 22.4 per cent normal in odor. This is an increase of 7.3 per cent for flavor and 8.6 per cent for odor, as compared with feeding one hour before milking. A more marked difference, however, was found in the decreased percentage of opinions rating the flavor and odor of the milk as off, there being 24.4 per cent decrease in the rating of flavor and 25.3 per cent decrease in the rating of odor. The percentage of opinions rating the milk as very slightly off and slightly off showed an increase of 13.4 per cent and 3.7 per cent, respectively, on flavor, and 7.8 per cent and 8.9 per cent, respectively, on odor, when compared with feeding one hour before milking.

Feeding green alfalfa three hours instead of one hour before milking does not eliminate the off flavors and odors to any great extent. It does, however, decrease the intensity of such flavors and odors. (Compare Tables 6 and 3; see fig. 2.)

Feeding 30 pounds of green alfalfa five hours before milking has practically no effect on the flavor and odor of the milk. Out of 106 opinions on 30 samples of milk produced by cows under these conditions, 88.7 per cent of the opinions rated the milk normal in flavor and 87.7 per cent normal in odor. While this is slightly lower than the per cent of normal opinions on the check samples, it is evident that the off flavors and odors due to feeding green alfalfa five hours before milking are practically negligible. (See Table 6 and fig. 2.)

TABLE 6.—*Opinions on flavor and odor of milk from cows fed 30 pounds of green alfalfa three and five hours before milking.*

Rating.	From cows fed 3 hours before milking (27 samples).				From cows fed 5 hours before milking (30 samples).			
	Flavor.		Odor.		Flavor.		Odor.	
	Opinons.	Per cent.	Opinions.	Per cent.	Opinions.	Per cent.	Opinions.	Per cent.
Normal	22	23.4	21	22.4	94	88.7	93	87.7
Very slightly off	20	21.3	14	14.9	3	2.8	3	2.8
Slightly off	29	30.8	29	30.8	8	7.6	6	5.7
Off	23	24.5	30	31.9	1	.9	4	3.8
Total	94	100.0	94	100.0	106	100.0	106	100.0

EFFECT OF IMMEDIATE AERATION OF THE MILK.

Proper aeration reduces off flavors and odors in the milk. In order to determine the effect of aeration on the flavor and odor of milk produced by cows fed from 10 to 15 pounds of green alfalfa one hour before milking, samples were taken, after which the milk while still warm was run over a surface cooler, cooling below 45° F., and samples were again taken. In 189 opinions on 53 samples treated in this manner, 46 per cent rated the flavor of the milk as normal before aeration, while 55 per cent gave the same rating to the milk

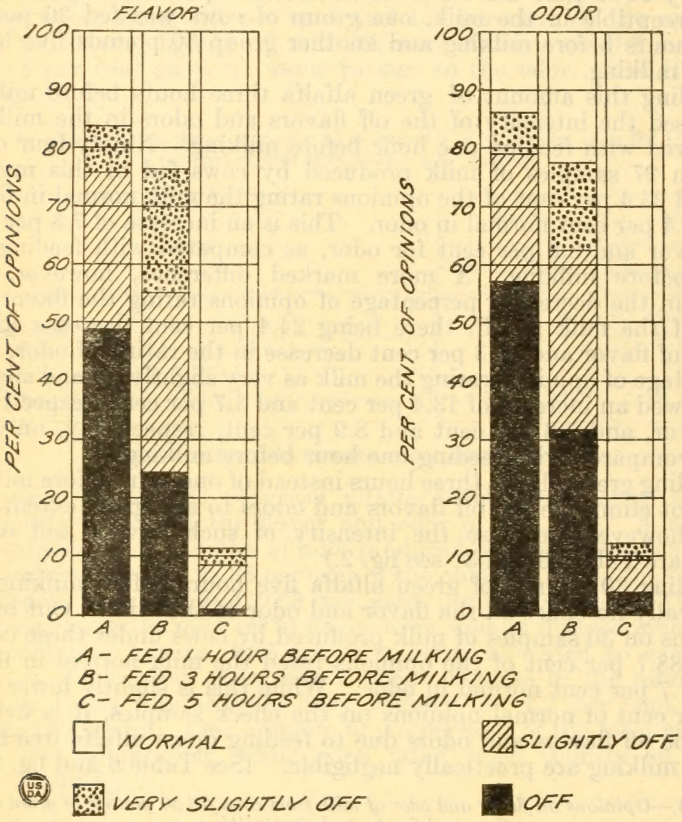

FIG. 2.—Effect on flavor and odor of milk from feeding 30 pounds of green alfalfa 1, 3, and 5 hours before milking. The degree of shading shows the relative intensity of the flavor and odor produced.

after aeration. Before aeration 19.1 per cent of the opinions rated the milk as off in flavor, which was reduced to 9 per cent by aeration. Likewise, the number of opinions rating the odor of the milk as normal was increased from 35.4 to 47.1 per cent and those rating the samples as off were reduced from 25.4 to 16.9 per cent by the same process. No great difference was found in the percentage of opinions rating the samples as slightly off and very slightly off on either flavor or odor. (See Table 7 and fig. 3.)

TABLE 7.—*Opinions on flavor and odor of 53 samples of milk, before and after aeration, from cows fed from 10 to 15 pounds of green alfalfa one hour before milking.*

Rating.	Flavor.				Odor.			
	Nonaerated.		Aerated.		Nonaerated.		Aerated.	
	Opinions.	Per cent.	Opinions.	Per cent.	Opinions.	Per cent.	Opinions.	Per cent.
Normal	87	46.0	104	55.0	67	35.4	89	47.1
Very slightly off	38	20.1	34	18.0	40	21.2	32	16.9
Slightly off	28	14.8	34	18.0	34	18.0	36	19.1
Off	36	19.1	17	9.0	48	25.4	32	16.9
Total	189	100.0	189	100.0	189	100.0	189	100.0

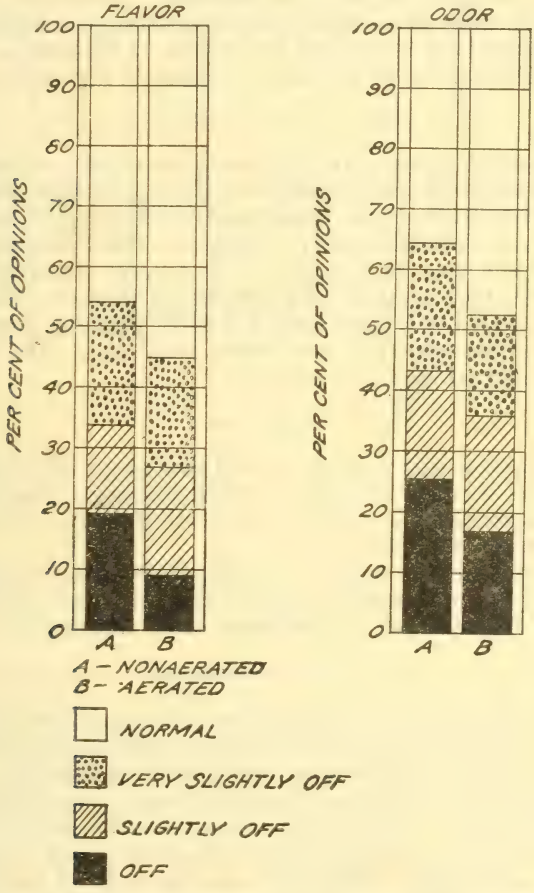

FIG. 3.—Effect of immediate aeration on flavor and odor of milk from cows fed from 10 to 15 pounds of green alfalfa 1 hour before milking. The degree of shading shows the relative intensity of the flavor and odor produced.

EXPERIMENTAL FEEDING OF GREEN CORN.

PROCEDURE.

In order to determine what effect feeding green corn has on the flavor and odor of milk, feeding experiments similar to those with green alfalfa were conducted. The samples were handled and judged in the same manner as those taken when green alfalfa was fed.

COWS.

Jersey and Holstein cows were used in the experiment. The average weight of the Holstein cows was 1,198 pounds; the Jerseys averaged 867 pounds. The average daily milk production of the Holstein cows was 28.5 pounds, the highest individual average being 33.9 pounds and the lowest 25.6 pounds. The Jersey cows gave an average daily milk production of 16.2 pounds, the highest individual average being 21.3 pounds and the lowest 11.3 pounds. The average daily milk production of all the cows was 23.4 pounds.

FEEDS OTHER THAN GREEN CORN.

In addition to green corn, the cows were fed varying amounts of the same grain mixture as was given during the green-alfalfa experiments, and the ration was completed by feeding what cured alfalfa hay the cows would readily consume. The average amount of grain fed daily was 11 pounds. The largest quantity received by any cow was 14.4 pounds, the smallest 5 pounds. The amount of alfalfa hay fed daily varied from 4.3 to 21 pounds, depending on the amount of green corn the cows were receiving. The average daily amount consumed was 11.7 pounds.

GREEN CORN.

The green corn was well eared and in a stage of maturity suitable for the silo. It was shredded before feeding. The same method of feeding was followed as with green alfalfa, except that only three groups were fed, namely:

One group (checks) was fed no green corn; one group was fed 25 pounds of green corn one hour before milking; and one group was fed 25 pounds of green corn immediately after milking.

CHECK SAMPLES.

Of the check samples, taken from the milk produced by cows receiving only the basic hay and grain ration, there were very few in which slightly off flavors or odors were perceptible. A total of 80 opinions on 25 samples of milk showed 92.5 per cent rating the milk normal in flavor and 93.8 per cent normal in odor. All the off flavors were rated as very slightly off, none being rated as slightly off or off. In the case of off odors, 3.7 per cent of the opinions rated the samples very slightly off and 2.5 per cent slightly off, while there were no opinions rating them as off. (See Table 8.)

TABLE 8.—*Opinions on flavor and odor of 25 samples of milk from cows fed basic ration of hay and grain (check cows).*

Rating.	Flavor.		Odor.	
	Opinions.	Per cent.	Opinions.	Per cent.
Normal	74	92.5	75	93.8
Very slightly off	6	7.5	3	3.7
Slightly off	0	.0	2	2.5
Off	0	.0	0	.0
Total	80	100.0	80	100.0

FEEDING 25 POUNDS ONE HOUR BEFORE MILKING.

Feeding green corn one hour before milking at the rate of 25 pounds, which constitutes a full feed for the average cow, proved to have but slight effect on either flavor or odor of milk. A total of 107 opinions on 32 samples of milk produced by cows fed in this manner showed 79.4 per cent of the opinions rating the milk normal in flavor and 86 per cent normal in odor. In the case of off flavors 14 per cent of the opinions rated the milk very slightly off and 6.6 per cent slightly off. Likewise 5.6 per cent of the opinions rated the milk very slightly off and 8.4 per cent slightly off in odor. None of the opinions rated the milk off in either flavor or odor. (See Table 9.)

TABLE 9.—*Opinions on flavor and odor of 32 samples of milk from cows fed 25 pounds of green corn one hour before milking.*

Rating.	Flavor.		Odor.	
	Opinions.	Per cent.	Opinions.	Per cent.
Normal	85	79.4	92	86.0
Very slightly off	15	14.0	6	5.6
Slightly off	7	6.6	9	8.4
Off	0	.0	0	.0
Total	107	100.0	107	100.0

FEEDING 25 POUNDS IMMEDIATELY AFTER MILKING.

Feeding 25 pounds of green corn immediately after milking had practically no effect on either flavor or odor of milk. A total of 98 opinions on 29 samples of milk produced by cows receiving this amount of green corn after milking showed 89.8 per cent rating the milk normal in flavor and 91.8 per cent normal in odor. The percentage of opinions rating the milk as very slightly off and slightly off was somewhat lower than when the green corn was fed before the milking, viz, 7.1 per cent and 3.1 per cent, respectively. Likewise, 5.1 per cent and 3.1 per cent of the opinions rated the odor of the milk very slightly off and slightly off, respectively. There were no opinions rating the milk off in either flavor or odor. (See Table 10.)

As compared with the check samples, the milk produced by cows fed this amount of green corn after milking showed a slightly higher

per cent of opinions rating the milk very slightly off and slightly off on both flavors and odor. This difference, however, was so small that it can be safely stated that feeding green corn in the quantity mentioned, after milking, affects neither the flavor nor the odor of the milk.

TABLE 10.—*Opinions on flavor and odor of 29 samples of milk from cows fed 25 pounds of green corn immediately after milking.*

Rating.	Flavor.		Odor.	
	Opinions.	Per cent.	Opinions.	Per cent.
Normal	88	89.8	90	91.8
Very slightly off	7	7.1	5	5.1
Slightly off	3	3.1	3	3.1
Off	0	.0	0	.0
Total	98	100.0	98	100.0

CONCLUSIONS.

Feeding green alfalfa to dairy cows at the rate of 30 pounds to each cow one hour before milking produced very pronounced off flavors and odors in the milk.

When the quantity fed was decreased to 15 pounds, the off flavors and odors were still present to an objectionable degree.

Increasing the time of feeding the green alfalfa to three hours before milking decreased the intensity of the off flavors and odors, but did not eliminate them.

Increasing the time of feeding green alfalfa to five hours before milking practically eliminated the off flavors and odors from the milk.

Feeding green alfalfa at the rate of 15 pounds to each cow immediately after milking had practically no bad effect on the flavor and odor of the milk.

When 30 pounds of green alfalfa were fed immediately after milking, the milk had less objectionable flavor and odor than milk from cows not fed green alfalfa.

It is advisable, when using green alfalfa as a soiling crop for dairy cows, to feed it after milking. When using it for pasture it is advisable to remove the cows from the pasture at least four or five hours before milking.

Proper aeration reduces strong off flavors and odors in milk, caused by feeding green alfalfa, and slightly off flavors and odors may be eliminated.

Feeding 25 pounds of green corn one hour before milking may produce slightly off flavors or odors in milk. They are only slight, however, and would seldom be perceived by the average consumer.

Feeding 25 pounds of green corn immediately after milking affects neither the flavor nor the odor of the milk.

At least 25 pounds of green corn, therefore, may be fed to dairy cows at any time without producing any objectionable flavors or odors in the milk.

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